are approximately correct. The solar distance of the arc at 1 p. m. was measured at 46½°, while the altitude of the sun at the same hour two days later was 66°. The sun's altitude at the moment considered must have been between 68° and 63°, where, according to the theory of Bravais, the solar distance of this arc should be between 46° and 47°. (See "Different forms of Halos and their Observation," MONTHLY WEATHER REVIEW, July, 1914.)

THE BLUE OF THE SKY AND AVOGADRO'S CONSTANT.[1]

By D. PACINI.

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Rayleigh's theory attributes the blue of the sky to molecular dispersion; but we have also to do with dust and with molecular agglomerations (on ions, on uncharged nuclei produced by the action of ultra-violet light on oxygen, or on water vapor) which are larger in size than the dimensions required by Rayleigh's theory, but which vary in size and number. The author has studied observed departures from the inverse fourth-power law, and tabulated the calculated value of n in λ^{-n}. It is mostly numerically smaller than 4, but has been found as large as 7. The observations are reduced to a series of typical curves, less or more in disaccord with the theoretical curve, and the probable causes of these discrepancies are considered. A perfect atmosphere would give data corresponding to about 62×10^{22} molecules per gram-molecule; the author finds his observations lead to a value of 57×10^{22}. Dember found by analogous methods 28, Abbot and Fowle 52, and King 62.3, $\times10^{22}$. On the whole, this is sufficient to show that the blue of the sky is mainly due to molecular dispersion.—*A. D[aniell]*.

PHOTOGRAPHY OF ZODIACAL LIGHT AND COUNTERGLOW.[2]

By A. E. DOUGLASS.

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Successful photographs of these phenomena of very slight contrast, were obtained by careful consideration of the conditions to give even illumination and intensification of photographic contrast. A camera lens of very large relative aperture was used (diameter 1 inch, focal length 2 inches), with exposures varying from 8 to 20 minutes. Equally good results were obtained with orthochromatic and ordinary plates, and it was found best to develop with hydroquinone bromide, kept cool, arranged for prolonged development. Evenness of illumination was got by using a special form of panoramic camera, with a focal diaphragm 17 mm. wide, the lens rotating at the rate of 2° per minute. The instrument was provided with three exactly similar lenses rotated by the same clock, so that three negatives were produced for each exposure. For producing positives, these negatives were put together and the copy taken through the combined pictures, thus increasing the contrast values given by a single film.

In the discussion of the paper the question was raised whether it might not be better to make a series of positives from each negative and superpose these for the increase of contrast instead of the negatives; also the importance in such work of attending to the perfect cleanliness of the lens surfaces, elimination of lens or camera glare, danger of diffraction with small apertures, etc.—*C. P. B[utler]*.

PROPAGATION OF SOUND IN THE ATMOSPHERE.[3]

By E. VAN EVERDINGEN.

[Reprinted from Science Abstracts, Sect. A, Apr. 25, 1916, § 458.]

In various investigations on the propagation over great distances of sounds from intense sources, specially in the case of volcanic eruptions and explosions, deviations have been found, partly regular, partly irregular. The source of sound is always surrounded by an area of regular or irregular shape, where the sound is heard everywhere, but the source is far from being always situated symmetrically within this area, and the dimensions of the latter are not even in the first place determined by the intensity of the sound. In many cases a second area of audibility occurs, separated from the first by a region where no sound at all is heard. Sometimes this second area partly surrounds the first; sometimes it consists only of isolated spots. It can be said generally that the smallest distance from the source of sound for this second area is usually much more than 100 kilometers and that the intensity of sound at this smallest distance is no less than at the outer border of the first area of audibility, which is much nearer to the source of sound. These facts are illustrated by diagrams of seven different cases which have previously been investigated. These are as follows: (1) Explosion of 15,000 kilograms of dynamite at Farde, in Westphalen, December 14, 1903 [G. von der Borne, Abs. 106 (1911)]; (2) explosion of 25,000 kilograms of dynamite near the Jungfrau Railway November 15, 1908 (A. de Quervain); (3) three eruptions of the volcano Asama in Japan on December 7, 1900, December 25, 1910, and April 4, 1911 (F. Fujiwhara); (4) explosion of gunpowder and dynamite at Kobe April 3, 1910 (S. Fujiwhara); (5) explosion of 200,000 kilograms of gunpowder in a magazine at Wiener-Neustadt on June 7, 1912 [J. N. Dörr, Abs. 1295 (1914)].

Two chief lines have been followed in the endeavor to explain these facts. The first way, now quite old, ascribes the abnormal propagation of sound to the influence of variations in temperature and wind velocity in the superposed layers of air in the atmosphere. It is easy to see how, by certain suppositions about the vertical distribution of wind velocity, the peculiarities of the propagation of sound, specially the silent region, may be explained. The influence of temperature, which decreases upward, is a decrease of the velocity of sound in the higher regions, thus causing the sound rays to curve upward from the earth. A horizontal wind in the direction of the sound, and with higher velocities at higher levels, may counteract the above temperature effect and overcome it, so turning the rays down again to the earth. A silent region followed by a second audible area is thus accounted for.

The second and entirely different line of thought was put forward by Von der Borne. He supposes that the appearance of silent regions, in some cases at least, may be due to the change in composition of the atmosphere, which is caused by the unequal decrease of the partial pressures of the constituents of the atmosphere. If no mixing by convection currents occurred, each of the gaseous constituents of the atmosphere would form an atmosphere entirely according to its own laws. In consequence

[1] Nuovo cimento, July-Aug., 1915, 10:131-167.
[2] Phot. jour., Feb. 1916, 56:44-47; discussion, 47-48.
[3] Proc., K. Acad. Amsterdam, 1916, 6, 18:933-960.

of this at great heights the denser gases could only occur as a very small percentage and the lighter constituents, of which hydrogen is the most generally known, must gradually begin to predominate. The convection currents alter this state of things only so far as the lower atmosphere (the troposphere) is concerned. Above 10 or 11 kilometers (at least in the Temperate Zone) little convection occurs, and above this level the change of composition is expected to begin. Also above that same level the fall of temperature with height ceases. As the velocity of sound in hydrogen is much greater than that in nitrogen or oxygen, it follows from this that at very great heights the velocity of sound increases so much that the sound rays are curved toward the earth.

In the light of these two competing theories the present author considers the following eight cases which have occurred during the present war: (1) Bombardment of Antwerp, October 7–9, 1914; (2) naval battle on the North Sea, October 17; (3) bombardment of German positions on the Yser by British naval guns, October 18; (4) heavy fighting on the line Ostend-Nieuport-Ypres, October 22; (5) heavy fighting at the Yser Canal, east of Ypres and south of Lille; (6) bombardment of German artillery in Flanders by 12-inch British naval guns, October 28; (7) severe attack of Germans on Ypres, British naval guns in action, heavy fighting at Dixmuiden, on the Lys, and at Messines; (8) naval battle on the North Sea, January 24, 1915. These cases are illustrated by maps and an elaborate table of the meteorological conditions at the times in question. Reviewing these cases, the author notes that the silent region is often displayed, and in the siege of Antwerp in an extraordinarily regular form.

Of the two explanatory theories put forward, the influence of variations of wind and temperature with height leads us to expect an asymmetry with respect to the source of sound and a difference between two mutually perpendicular directions, and permits of all kinds of distances. The physical explanation, on the other hand, requires complete symmetry with respect to the source of sound. It is found that the outer limit of the silent region is only slightly changed by considerable irregularities in the distribution of wind or temperature.

Probably many of the cases observed are explicable on the meteorological theory, although there is not absolute proof of this. In favor of the physical theory it must be noted that the border of the silent region has been always at about 160 kilometers from the probable source of sound and that no appreciable deviations from the circular form have been found.—*E. H. B[arton].*

SPONTANEOUS IONIZATION OF THE AQUEOUS VAPOR OF THE ATMOSPHERE. II.[4]

By G. ODDO.

[*Reprinted from* Science Abstracts, Sect. A, Apr. 25, 1916, §460.]

The author discusses the various views which have been expressed concerning the origin of atmospheric electricity, this being connected largely, if not entirely, with the presence of water vapor. The molecules of the latter, being in a rarified or diluted state, undergo spontaneous ionization in the same way as do electrolytes in dilute aqueous solution; the ionized aqueous vapor of the atmosphere acts, therefore, as a conductor of the second class. In comparison with this source of ions, all other sources, such as the actions of ultra-violet radiation from the sun and of terrestrial radioactive substances, etc., must be regarded as subsidiary.

From the specific humidity of the air, the number of molecules contained in one gram-molecule of a gas, and the number of ions formed from 100 molecules of water at different temperatures, the ionic concentration is calculated for various temperatures and pressures. Fall of temperature diminishes the proportion of water vapor in the air, but starting from 32°C. increases its degree of ionisation. The calculations now made show that the ionic concentration, C_1, is highest and approximately constant between 5° and 20°; it remains high even at −10°C., but diminishes rapidly between −10° and −20°, in spite of the rapid increase in the degree of ionization; it is also high at 25°, decreasing rapidly at higher temperatures and becoming virtually zero at 32°. With varying pressure the ionic concentration changes nearly in accordance with Boyle's law, $p \times C_1 = K$. It will be seen that the ionic concentration of the atmosphere is at its maximum for those conditions of temperature which are most suitable to animal and vegetable life, and it may be assumed that the latter constitutes a true indicator of this ionic concentration.

At 15° and a pressure of 760 millimeters, 1 kilogram of moist air, occupying 773.4 liters at 0° and 760 millimeters in the dry state, contains 89×10^{-20} hydrogen and hydroxyl ions, and such marked ionization would lead to the supposition that many processes of oxidation and reduction, occurring in contact with air, are electrolytic in character. A number of natural processes of the inorganic, vegetable, and animal kingdom are discussed on these lines.—*T. H. P[ope.]*

VARIATION OF EMANATION CONTENT OF SPRINGS.[5]

By R. R. RAMSEY.

[*Reprinted from* Science Abstracts, Sect. A, Apr. 25, 1916, §451.]

An examination of the variation of the emanation content of certain springs shows roughly that an increase coincides with a season of rain and a decrease with dry weather.—*A. B. W[ood.]*

PLANETARY PHENOMENA AND SOLAR ACTIVITY.[6]

By T. KÖHL.

[*Reprinted from* Science Abstracts, Sect. A, Mar. 25, 1916, §297.]

Jupiter's northern cloud belts appear to be specially weak at times of sun-spot maxima and become broader and more conspicuous during minima. The secondary light on the dark side of Venus is mentioned in relation to the occurrence of auroral displays on the earth.—*C. P. B[utler.]*

FREE-AIR DATA BY MEANS OF SOUNDING BALLOONS, FORT OMAHA, NEBR., JULY, 1914.

WILLIAM R. BLAIR, Professor of Meteorology in charge.

[Dated: Aerological Investigations, Weather Bureau, Washington, Mar. 10, 1916.]

The primary purpose of this series of observations was the study of the diurnal variation of the different meteorological elements observed at the higher levels. Our observation of this variation[1] had heretofore been by

[4] Gazz., Soc. chim. Ital., 1915, 1, 45: 395–412.

[5] Proc., Indiana acad. sci., 1914, p. 489.

[6] Astron. Nachr. No. 4821. *Abstracted* in Nature, Jan. 6, 1916, 96: 521.

[1] The diurnal system of convection, Bulletin of the Mount Weather Observatory, 1914, 6, part 5, pp. 221-252.